

which were very difficult to treat in finished form because they became distorted.

Need to press treated wool garments after laundering will soon be a thing of the past. True no-iron fabrics made from blends of the treated wool and modified cellulosic fibers are already on the market. The cellulosic component of these blends contributes its excellent no-ironing effect, while the wool gives the fabric esthetic values, wrinkle resistance, warmth, and resiliency. All-wool fabrics which require no ironing are now a major subject of research.

Cheap and long-lasting finishes to make wool fabrics oil repellent and water repellent may soon be available. New fluorine compounds discovered by Dr. Allen G. Pittman at the Albany

laboratory confer repellency to oil, water, and the soils carried by oil and water. Several new families of fluoro chemicals have been prepared, and some of the most promising of these should be far more economical to make and use than any related materials now known.

Goal of the staff at the Wool and Mohair Laboratory is to find a single treatment which gives multipurpose benefits to wool. But even without a one-shot process, these various new treatments for wool are widening the scope of use for this elegant fabric. With soil resistance and wrinkle resistance, machine washability, and longer wear life, even children's clothes and apparel in delicate pastel colors are practical. We can have our luxury and afford to maintain it, too.

## *Frozen Foods— New Techniques*

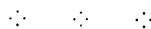
J. G. WOODROOF

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From field to dinner table, frozen foods have won a place for themselves. Farmers grow varieties of plants just for freezing. Equipment has been developed exclusively for harvesting, handling, processing, storing, and hauling frozen foods. Eating establishments routinely use hundreds of frozen food items. The housewife uses frozen foods in most of her meals.

One of the secrets in frozen food quality is quick freezing. The trend in preparing, storing, and using frozen foods has been to use lower and lower temperatures. This increases the rate of freezing, reduces labor costs, better retains the quality of food, and adds certain conveniences to using.

Before 1928, meats, fish, strawberries from the Northwest, and a few other foods were bulk "sharp frozen." The washed and graded products were packed in barrels or other large containers and placed at 0° F. until they froze. This kept them from spoiling and preserved the "freshness" fairly well—that is, better than heat-processed foods and those that laid on the fresh produce counter for several days. From many hours to a week was required for the foods to freeze solid.



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Much of the processing took place after the product was thawed.

"Quick freezing" was applied to products frozen in a half hour or less and was begun about 1929. This required smaller containers and closer contact of the food with the refrigerant. For quick freezing, foods were prepared for the table, frying pan, or broiler before being packaged. This eliminated waste and added maximum convenience.

The most commonly used quick-freezing method is by placing filled consumer-size containers of food between metal plates at  $-40^{\circ}$  F. Freezing begins almost immediately and is complete in an hour.

A second way is by placing consumer-size containers of food on trays and subjecting them to a blast of air at  $0^{\circ}$  to  $-40^{\circ}$  F. About twice as long is required to freeze packages by air-blast as on cold plates, yet the difference in quality of product frozen by the two methods is not great.

In the homefreezer, prepackaged foods are quick frozen on cold plates in the freezing compartment and in

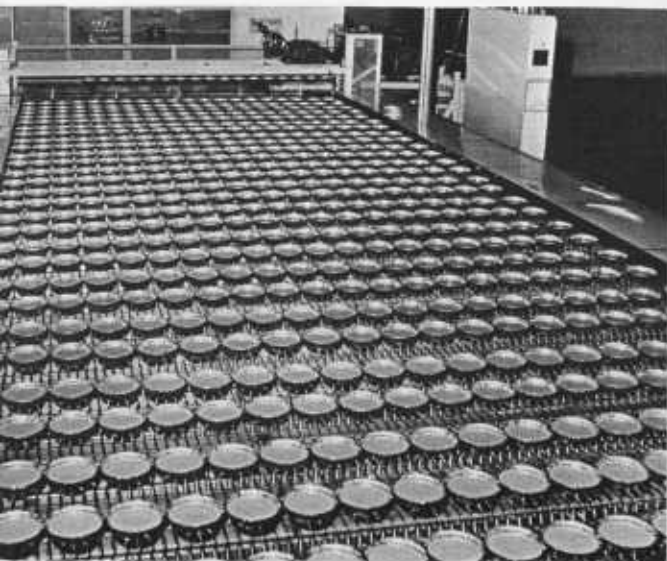
cold air in the storage compartment. Here again, the difference in quality is negligible for either method.

A third way of quick freezing is spreading such products as peas, beans, berries, diced carrots, and shrimp on a wire mesh belt and slowly moving them through a freezing tunnel at about  $-40^{\circ}$  F. The individually frozen product is scraped off the belt and packaged in bulk or in consumer-size containers.

An improvement of "belt freezing" is "fluidized freezing" in which a current of cold air is passed upward through the metal belt, lifting the product off the belt, and causing it to tumble and freeze in air. This not only produces quick freezing, but prevents the individual pieces from sticking together and allows each piece to freeze equally from all sides. Freezing is so quick there is little drying.

Cryogenic freezing is freezing with liquid nitrogen ( $-320^{\circ}$  F.), liquid or solid carbon dioxide ("dry ice" at  $-109^{\circ}$  F.), liquid air, or other low-temperature refrigerants. These refrigerants have been used for holding

Cream cheese cakes, *left*, move from bakery oven toward blast freezer where they are frozen within minutes to "stop the clock" at the peak of freshness and flavor. *Right*, housewife selects frozen concentrated orange juice at a market.



and shipping frozen foods in a limited way since about 1928, though the product seldom reached the refrigerant temperature.

However, about 1960 commercial installations for cryogenic freezing became available. And since 1965, fleets of trailers on the highways, "piggy-back trailers" on railway flatcars, and insulated railway cars have been equipped with liquid nitrogen facilities. Operational installations tripled in each succeeding year.

Increased experience, widening availability of liquid nitrogen and carbon dioxide, rapidly dwindling costs, and more stringent laws regulating the temperature of frozen foods favor cryogenic freezing. Besides freezing foods rapidly, it quickly reduces the temperature of entire loads of foods while in transit.

Freezing foods very quickly has several advantages qualitywise. Succulent vegetables like green beans, asparagus, and okra, and fruits with delicate texture like whole strawberries and sliced pineapples and peaches, have much firmer texture with greatly reduced leakage of juices when frozen very rapidly. Freezing by cryogenics produces qualities in most frozen foods that are closer to the fresh state than any other process now being used commercially. This applies to the appearance, color, and palatability of these foods. Nitrogen is inert and does not react with the product or with its constituents.

These advantages make it practical to freeze many products previously considered unsuitable for freezing. Products that are or may be frozen by this method include such hitherto unlikely candidates as whole peeled bananas, avocados, pineapples, fresh mushrooms, green peppers, onion rings, watermelon, and tomatoes as well as a wider variety of seafoods including lobster, scallops, flounder fillets, and raw and cooked shrimp. One plant in Florida froze more than 15 million pounds of shrimp with liquid nitrogen in 1966 and an even larger quantity in 1967.

Shrinkage during freezing by cryogenics may be under 1 percent, less than with any other freezing method.

The cost of freezing with liquid nitrogen or carbon dioxide is initially 3 to 5 cents per pound, which is high compared with 1 cent for sharp freezing. But an advantage is being able to save a shipment from possible total loss while in transit.

With cryogenics, freezing may be complete or just "case frozen" (freezing the outside very quickly and allowing the inside to freeze more slowly). Complete freezing, by reducing the temperature in the center of each piece to that of the freezing medium, is seldom accomplished. This is because more time would be required, no appreciable difference in quality would result, and the berries, peas, or other particles would likely break due to the sudden expansion of the centers.

Possibly the highest quality frozen produce is produced at the lowest cost by "case freezing" the outside of each piece with liquid nitrogen, and allowing the inside to freeze by a slower and cheaper method, such as fluidizing.

Liquid nitrogen systems have almost entirely eliminated potential hazards from mechanical failure in transportation. Special trailers are designed to handle four tanks of liquid nitrogen. These are serviced from 500-gallon supply stations across the Nation. This system provides delivery of frozen foods to any point in the country in the best condition at the lowest cost. In many cases, mechanical units on trailers supply the regular needs while liquid nitrogen is used for quick cooling purposes.

Some foods do not require instant freezing. The differences in quality due to method of freezing vary with the products.

For many, and perhaps most products, the physical differences between instant and slower frozen products is not markedly apparent.

In products such as candies, fruit cakes, precooked meats and vegetables, and prepared meals, the differences are

virtually nonexistent. In candies, there are no cells to rupture, and in precooked products, the cells have already been altered by cooking. In fruit cakes, the high sugar concentration protects the tissues from damage.

One may not need to go to "instant" freezing to obtain all the quality improvement practical in the home or commercial operations. In most cases, an excellent product can be had by using a generally available freezing temperature ranging from  $-10^{\circ}$  to  $-40^{\circ}$  F. and giving more attention to other factors relating to quality.

Often more important than the method of freezing are factors like variety, maturity, method of preparation and packaging, and kind and shape of package.

One of the main reasons for freezing foods quickly is to minimize microbial spoilage. This is especially true with

precooked foods that must pass through a warm zone between cooking and freezing. Fruits that are not heated may mold or otherwise deteriorate if freezing is delayed. Quick freezing is very important in preventing microbial spoilage of cooked foods like meat pies, fowl stuffing, and meat and vegetable dishes.

In freezing, the rate of heat removal is important, not the temperature of the freezing medium. Widely different rates of freezing may occur at a given temperature, depending upon whether the product is packaged or is loose, the density of the product, the rate of the airflow, and the amount of metal contact.

Because of the short harvesting season for peas, green beans, corn, lima beans, and diced carrots, large amounts of these vegetables are frozen loose and bulk packaged in portable bins (tote boxes) holding about 1,300 pounds. The bins are made of corrugated fiber or plywood boards and lined with polyethylene film sheets. They are placed close to the freezer, and the frozen vegetables travel directly from the freezer to the bins through 6- to 8-inch tubes. The plastic sheets are folded over the product, which is stored for later packaging into consumer-size packages. Some plants freeze up to 10,000 pounds of vegetables per hour, for holding in portable bins.

During the slack season, peas and green beans from the Northwest, corn from the Midwest, carrots from Texas, and lima beans from California can be packaged together. Strawberries, cherries, and raspberries are sometimes repackaged also.

Advantages of bulk freezing are:

- The products are hurriedly prepared and frozen at the peak of the season and stored for subsequent packaging.
- Packaging and labeling are done at slack seasons, thereby equalizing the labor load.
- Special packs of mixed vegetables or mixed fruits can be prepared throughout the year on demand.

Grapes on belt entering nitrogen freezer.



- The transportation of bulk frozen products from one section of the country to another is cheaper and requires less space.

- The same grade of frozen products can be packed and distributed under separate labels.

A disadvantage in bulk freezing and storage is that double handling into and out of storage is required.

Low labor and costs are provided by frozen prepared entrees packed in 12-by-20-inch disposable aluminum steamtable pans. Each pan holds 18 pounds of food. Shipped two pans per carton, they are the same size as conventional steamtable pans and can be set right on the serving line. Entrees include chicken fricassee, turkey a la king, sliced turkey and gravy, sirloin tips and gravy, individual meat loaves, beef stew, sliced beef and gravy, and spaghetti sauce with meat.

In a few hours, one or two persons can prepare and set up for serving enough food for hundreds of customers.

Small freezers with as little as 6 cubic feet of storage space and requiring floorspace of 27 by 27 inches are available in stainless steel, maple-top, or undercounter models. They operate on 115 volts, but have no moving parts.

More than 2,000 frozen food items are on the market, and they are increasing constantly. Where formerly each kind of vegetable, fruit, meat, or fish was frozen separately, they are now cooked and combined into many dishes, dinners, or trays. There seems no end to the possible combinations of frozen foods.

Some of the frozen prepared dishes that have recently appeared on the market are crabsticks, cocktail deviled crabs, deviled crabs, fried clams, fried soft-shell clams, stuffed flounder, stuffed peppers, whipped sweetpotato casserole, apple crisp, 1-, 2-, and 5-pound packs of meat loaf, macaroni and cheese, oven-baked beans, barbecued beef, beef stew, sliced roast beef with gravy, Italian beef, sage dressing, meat ravioli, veal parmigiana, pork liver, chop suey, and chili con carne.

In addition, there are dozens of kinds

of pies such as chicken, meat, turkey, cherry, apple, apricot, and others.

Containers for frozen foods must protect the product from drying out (freezer burn) and discoloring by oxidation. They must also be of suitable material for cooking and serving the food in the package. Most vegetables are frozen in boil-in bags that can be cooked and served directly from the bags. Meat pies, TV dinners, and casseroles are completely prepared, seasoned, and frozen in metal trays so they can be cooked and served from the freezing containers. Ease of cooking without waste, and convenience of serving without leftovers, is accomplished by innovations in frozen food containers.

Freezing methods and handling innovations now in the developmental stage include:

A tubular container with a tear thread which may also serve as a freezing and cooking utensil and a dish from which the cooked food can be eaten directly (U.S. Patent 3,301,687).

A two-stage process in which unfrozen food particles are tumbled with gaseous coolants along a spiral path to bring them to a predetermined subfreezing temperature (U.S. Patent 3,300,993).

Retail packages of frozen foodstuffs are sealed in an insulating container which remains unopened until moved to a dispensing station at the retail area (U.S. Patent 3,302,420).

A process for molding and freezing together irregularly shaped food items (U.S. Patent 3,300,994).

Freezing apparatus including an insulating cold treatment chamber in which a foodstuff may be subjected to either a rain of liquid nitrogen or total immersion (U.S. Patent 3,302,423).

A freezing process in which cold vapor evolved from liquid nitrogen is directed down an incline in heat exchange relationship to food items being conveyed up the incline. Liquid nitrogen is sprayed upon the cooled foods to partially freeze them (U.S. Patent 3,298,188).